#4

SEQUENCE LISTING

<110> Pompejus, Markus
Suelberger, Harald
Joeffken, Hans Wolfgang
Doval, Jose Luis Revuelta
Jimenez, Alberto;
Garcia, Maria Angeles Santos

<120> Genes of purine biosynthesis from Ashbya Gossypii and the use thereof in microbial riboflavin synthesis

<130> 48684DIV

<140> US 10/076,157
<141> 2002-02-15

<150> US 09/212,247
<151> 1998-12-16

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caccacttcc cgccaaacaa tctgcacttt acgagcgcta tctatccctc gggtcgctct 360

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gttattgacg ccgcaatcct acgcc atg tcg tcc aat agc ata aag ctg cta 652
Met Ser Ser Asn Ser Ile Lys Leu Leu
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gca ggt aac tcg cac ccg gac cta gct gag aag gtc tcc gtt cgc cta      700
Ala Gly Asn Ser His Pro Asp Leu Ala Glu Lys Val Ser Val Arg Leu
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ggt gta cca ctt tcg aag att gga gtg tat cac tac tct aac aaa gag      748
Gly Val Pro Leu Ser Lys Ile Gly Val Tyr His Tyr Ser Asn Lys Glu
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acg tca gtt act atc ggc gaa agt atc cgt gat gaa gat gtc tac atc      796
Thr Ser Val Thr Ile Gly Glu Ser Ile Arg Asp Glu Asp Val Tyr Ile
             45                  50                  55

atc cag aca gga acg ggg gag cag gaa atc aac gac ttc ctc atg gaa      844
Ile Gln Thr Gly Thr Gly Glu Gln Glu Ile Asn Asp Phe Leu Met Glu
         60                  65                  70

ctg ctc atc atg atc cat gcc tgc cgg tca gcc tct gcg cgg aag atc      892
Leu Leu Ile Met Ile His Ala Cys Arg Ser Ala Ser Ala Arg Lys Ile
     75                  80                  85

aca gcg gtt ata cca aac ttc cct tac gca aga caa gac aaa aag gac      940
Thr Ala Val Ile Pro Asn Phe Pro Tyr Ala Arg Gln Asp Lys Lys Asp
 90                  95                 100                 105

aag tcg cga gca ccg ata act gcc aag ctg gtg gcc aag atg cta gag      988
Lys Ser Arg Ala Pro Ile Thr Ala Lys Leu Val Ala Lys Met Leu Glu
                110                 115                 120

acc gcg ggg tgc aac cac gtt atc acg atg gat ttg cac gcg tct caa     1036
Thr Ala Gly Cys Asn His Val Ile Thr Met Asp Leu His Ala Ser Gln
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att cag ggt ttc ttc cac att cca gtg gac aac cta tat gca gag ccg     1084
Ile Gln Gly Phe Phe His Ile Pro Val Asp Asn Leu Tyr Ala Glu Pro
        140                 145                 150

aac atc ctg cac tac atc caa cat aat gtg gac ttc cag aat agt atg     1132
Asn Ile Leu His Tyr Ile Gln His Asn Val Asp Phe Gln Asn Ser Met
    155                 160                 165

ttg gtc gcg cca gac gcg ggg tcg gcg aag cgc acg tcg acg ctt tcg     1180
Leu Val Ala Pro Asp Ala Gly Ser Ala Lys Arg Thr Ser Thr Leu Ser
170                 175                 180                 185

gac aag ctg aat ctc aac ttc gcg ttg atc cac aaa gaa cgg cag aag     1228
Asp Lys Leu Asn Leu Asn Phe Ala Leu Ile His Lys Glu Arg Gln Lys
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gcg aac gag gtc tcg cgg atg gtg ttg gtg ggt gat gtc gcc gac aag     1276
Ala Asn Glu Val Ser Arg Met Val Leu Val Gly Asp Val Ala Asp Lys
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tcc tgt att att gta gac gac atg gcg gac acg tgc gga acg cta gtg     1324
Ser Cys Ile Ile Val Asp Asp Met Ala Asp Thr Cys Gly Thr Leu Val
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aag gcc act gac acg ctg atc gaa aat tgt gcg aaa gaa gtg att gcc     1372
Lys Ala Thr Asp Thr Leu Ile Glu Asn Cys Ala Lys Glu Val Ile Ala
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250                 255                 260                 265

aac agc aag ctg gca cgg atc gta agc aca aat acg gtg cca gtg gac      1468
Asn Ser Lys Leu Ala Arg Ile Val Ser Thr Asn Thr Val Pro Val Asp
                270                 275                 280

ctc aat cta gat atc tac cac caa att gac att agt gcc att ttg gcc      1516
Leu Asn Leu Asp Ile Tyr His Gln Ile Asp Ile Ser Ala Ile Leu Ala
            285                 290                 295

gag gca att aga agg ctt cac aac ggg gaa agt gtg tcg tac ctg ttc      1564
Glu Ala Ile Arg Arg Leu His Asn Gly Glu Ser Val Ser Tyr Leu Phe
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aat aac gct gtc atg tagtgctgtc agtggcagat gcatgatcgc tggcctaatt      1619
Asn Asn Ala Val Met
    315

atctgtgtaa gttgatacaa tgcagtaaat acagtacata aaactgaatg tttttcactt    1679

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cgtaatgaat acaaacaaga ttgcacatta ggaaaagcga taaattattt attatttgca    1799

actggccttt gagcgtttaa gcctgaacat ttttgccctt ttgtttgacc gtaccgttat    1859

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Gly Val Tyr His Tyr Ser Asn Lys Glu Thr Ser Val Thr Ile Gly Glu
         35                  40                  45

Ser Ile Arg Asp Glu Asp Val Tyr Ile Ile Gln Thr Gly Thr Gly Glu
     50                  55                  60

Gln Glu Ile Asn Asp Phe Leu Met Glu Leu Leu Ile Met Ile His Ala
 65                  70                  75                  80

Cys Arg Ser Ala Ser Ala Arg Lys Ile Thr Ala Val Ile Pro Asn Phe
                 85                  90                  95

Pro Tyr Ala Arg Gln Asp Lys Lys Asp Lys Ser Arg Ala Pro Ile Thr
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            100                 105                 110

Ala Lys Leu Val Ala Lys Met Leu Glu Thr Ala Gly Cys Asn His Val
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Ile Thr Met Asp Leu His Ala Ser Gln Ile Gln Gly Phe Phe His Ile
    130                 135                 140

Pro Val Asp Asn Leu Tyr Ala Glu Pro Asn Ile Leu His Tyr Ile Gln
145                 150                 155                 160

His Asn Val Asp Phe Gln Asn Ser Met Leu Val Ala Pro Asp Ala Gly
                165                 170                 175

Ser Ala Lys Arg Thr Ser Thr Leu Ser Asp Lys Leu Asn Leu Asn Phe
            180                 185                 190

Ala Leu Ile His Lys Glu Arg Gln Lys Ala Asn Glu Val Ser Arg Met
        195                 200                 205

Val Leu Val Gly Asp Val Ala Asp Lys Ser Cys Ile Ile Val Asp Asp
    210                 215                 220

Met Ala Asp Thr Cys Gly Thr Leu Val Lys Ala Thr Asp Thr Leu Ile
225                 230                 235                 240

Glu Asn Cys Ala Lys Glu Val Ile Ala Ile Val Thr His Gly Ile Phe
                245                 250                 255

Ser Gly Gly Ala Arg Glu Lys Leu Arg Asn Ser Lys Leu Ala Arg Ile
            260                 265                 270

Val Ser Thr Asn Thr Val Pro Val Asp Leu Asn Leu Asp Ile Tyr His
        275                 280                 285

Gln Ile Asp Ile Ser Ala Ile Leu Ala Glu Ala Ile Arg Arg Leu His
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Asp Arg Gly Cys Lys Gly Ile Ser Tyr Val Leu Ser Ala Met Val Phe
                5                  10                  15

cac ata ata ccg att aca ttt gaa ata tcg atg gta tgt ggc ata ttg          153
His Ile Ile Pro Ile Thr Phe Glu Ile Ser Met Val Cys Gly Ile Leu
            20                  25                  30

aca tac cag ttt ggt gct tcc ttc gct gct ata aca ttc tcg act atg          201
Thr Tyr Gln Phe Gly Ala Ser Phe Ala Ala Ile Thr Phe Ser Thr Met
        35                  40                  45

ctt ctt tac tcc atc ttt act ttc aga acg acg gcg tgg cgc aca cgg          249
Leu Leu Tyr Ser Ile Phe Thr Phe Arg Thr Thr Ala Trp Arg Thr Arg
    50                  55                  60                  65

ttt agg cgt gat gcg aac aag gct gac aat aag gcc gct agt gtg gca          297
Phe Arg Arg Asp Ala Asn Lys Ala Asp Asn Lys Ala Ala Ser Val Ala
                70                  75                  80

ttg gat tcc cta ata aat ttt gaa gct gta aag tat ttc aat aac gag          345
Leu Asp Ser Leu Ile Asn Phe Glu Ala Val Lys Tyr Phe Asn Asn Glu
            85                  90                  95

aag tac ctt gcg gac aag tat cac aca tcc ttg atg aag tac cgg gat          393
Lys Tyr Leu Ala Asp Lys Tyr His Thr Ser Leu Met Lys Tyr Arg Asp
        100                 105                 110

tcc cag ata aag gtc tcg caa tcg ctg gcg ttt ttg aac acc ggc cag          441
Ser Gln Ile Lys Val Ser Gln Ser Leu Ala Phe Leu Asn Thr Gly Gln
    115                 120                 125

aac cta att ttt acc act gca ctg act gca atg atg tat atg gcc tgt          489
Asn Leu Ile Phe Thr Thr Ala Leu Thr Ala Met Met Tyr Met Ala Cys
130                 135                 140                 145

aat ggt gtt atg cag ggc tct ctt aca gtg ggg gat ctt gtg tta att          537
Asn Gly Val Met Gln Gly Ser Leu Thr Val Gly Asp Leu Val Leu Ile
                150                 155                 160

aat caa ctg gta ttc cag ctc tcc gtg cca cta aac ttc ctt ggt agc          585
Asn Gln Leu Val Phe Gln Leu Ser Val Pro Leu Asn Phe Leu Gly Ser
            165                 170                 175

gtc tac cgt gat ctc aag cag tct ctg ata gat atg gaa tct tta ttt          633
Val Tyr Arg Asp Leu Lys Gln Ser Leu Ile Asp Met Glu Ser Leu Phe
        180                 185                 190

aaa ctg caa aaa aat cag gtc aca att aag aac tcc cca aat gcc cag          681
Lys Leu Gln Lys Asn Gln Val Thr Ile Lys Asn Ser Pro Asn Ala Gln
    195                 200                 205

aac cta cca ata cac aaa ccg ttg gat att cgc ttt gaa aat gtt acg          729
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Asn Leu Pro Ile His Lys Pro Leu Asp Ile Arg Phe Glu Asn Val Thr
210                 215                 220                 225

ttt ggc tat gac ccg gag cgg cgt ata ttg aac aat gtt tcg ttt acc      777
Phe Gly Tyr Asp Pro Glu Arg Arg Ile Leu Asn Asn Val Ser Phe Thr
                230                 235                 240

atc cca gct gga atg aag act gcc ata gta ggc cca tcg ggc tcg ggg      825
Ile Pro Ala Gly Met Lys Thr Ala Ile Val Gly Pro Ser Gly Ser Gly
            245                 250                 255

aag tcc acc att ttg aag ctc gta ttt aga ttc tat gag ccc gag caa      873
Lys Ser Thr Ile Leu Lys Leu Val Phe Arg Phe Tyr Glu Pro Glu Gln
        260                 265                 270

ggt cgt atc cta gtt ggc ggc aca gat atc cgc gat tta gac ttg ctt      921
Gly Arg Ile Leu Val Gly Gly Thr Asp Ile Arg Asp Leu Asp Leu Leu
    275                 280                 285

tct tta cgg aag gct atc ggt gtc gtg ccc caa gat act cct ctc ttc      969
Ser Leu Arg Lys Ala Ile Gly Val Val Pro Gln Asp Thr Pro Leu Phe
290                 295                 300                 305

aat gac aca atc tgg gag aat gtt aaa ttc ggc aat atc agt tcc tct     1017
Asn Asp Thr Ile Trp Glu Asn Val Lys Phe Gly Asn Ile Ser Ser Ser
                310                 315                 320

gac gat gag att ctc agg gcc ata gaa aaa gct caa ctc acg aag cta     1065
Asp Asp Glu Ile Leu Arg Ala Ile Glu Lys Ala Gln Leu Thr Lys Leu
            325                 330                 335

ctc cag aac cta cca aag ggc gct tcc acc gtt gta ggg gag cgc ggt     1113
Leu Gln Asn Leu Pro Lys Gly Ala Ser Thr Val Val Gly Glu Arg Gly
        340                 345                 350

ttg atg atc agc gga ggt gag aaa caa agg ctt gct att gct cgt gtg     1161
Leu Met Ile Ser Gly Gly Glu Lys Gln Arg Leu Ala Ile Ala Arg Val
    355                 360                 365

ctt ttg aag gac gct ccg ctg atg ttt ttc gac gag gct aca agt gct     1209
Leu Leu Lys Asp Ala Pro Leu Met Phe Phe Asp Glu Ala Thr Ser Ala
370                 375                 380                 385

ctg gat aca cac aca gag cag gca ctc ttg cac acc att cag cag aac     1257
Leu Asp Thr His Thr Glu Gln Ala Leu Leu His Thr Ile Gln Gln Asn
                390                 395                 400

ttt tct tcc aat tca aag acg agc gtt tac gtt gcc cat aga ctg cgc     1305
Phe Ser Ser Asn Ser Lys Thr Ser Val Tyr Val Ala His Arg Leu Arg
            405                 410                 415

aca atc gct gat gca gat aag atc att gtt ctt gaa caa ggt tct gtc     1353
Thr Ile Ala Asp Ala Asp Lys Ile Ile Val Leu Glu Gln Gly Ser Val
        420                 425                 430

cgc gaa gag ggc aca cac agc tcg ctg tta gcg tca caa gga tcc cta     1401
Arg Glu Glu Gly Thr His Ser Ser Leu Leu Ala Ser Gln Gly Ser Leu
    435                 440                 445
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tac cgg ggt ctg tgg gat att cag gaa aac cta acg ctt ccg gaa cgg      1449
Tyr Arg Gly Leu Trp Asp Ile Gln Glu Asn Leu Thr Leu Pro Glu Arg
450                 455                 460                 465

cct gag cag tca acc gga tct cag cat gca tagacgtctg actagagatt      1499
Pro Glu Gln Ser Thr Gly Ser Gln His Ala
                470                 475

atataataac cctcgagcca aaattatacg gcgctaacaa gtaaaaattt tagttacttt  1559

tctgacttct ctacgctgac ttctctaccc ttctaacata gttaattgaa gtagtggtta  1619

atgacgactg cattttatta ttgtccactt tgcattagaa gtactagtgc ttaagcgctc  1679

tttaggccgc tttcttcttc tttgtcaggc cgcaaggtaa aggaagcacc aacggattgc  1739

taccgctgct attcctgctc tctcaag atg tgt ggc ata tta ggc gtt gtg      1790
                            Met Cys Gly Ile Leu Gly Val Val
                                                480

cta gcc gat cag tcg aag gtg gtc gcc cct gag ttg ttt gat ggc tca    1838
Leu Ala Asp Gln Ser Lys Val Val Ala Pro Glu Leu Phe Asp Gly Ser
    485                 490                 495

ctg ttc tta cag cat cgc ggt caa gat gct gcc ggg att gct acg tgc    1886
Leu Phe Leu Gln His Arg Gly Gln Asp Ala Ala Gly Ile Ala Thr Cys
500                 505                 510                 515

ggc ccc ggt ggg cgc ttg tac caa tgt aag ggc aat ggt atg gca cgg    1934
Gly Pro Gly Gly Arg Leu Tyr Gln Cys Lys Gly Asn Gly Met Ala Arg
                520                 525                 530

gac gtg ttc acg caa gct cgg atg tca ggg ttg gtt ggc tct atg ggg    1982
Asp Val Phe Thr Gln Ala Arg Met Ser Gly Leu Val Gly Ser Met Gly
            535                 540                 545

att gca cac ctg aga tat ccc act gca ggc tcc agt gcg aac tca gaa    2030
Ile Ala His Leu Arg Tyr Pro Thr Ala Gly Ser Ser Ala Asn Ser Glu
        550                 555                 560

gcg cag cca ttc tat gtg aat agt ccc tac gga att tgc atg agt cat    2078
Ala Gln Pro Phe Tyr Val Asn Ser Pro Tyr Gly Ile Cys Met Ser His
    565                 570                 575

aat ggt aat ctg gtg aac acg atg tct cta cgt aga tat ctt gat gaa    2126
Asn Gly Asn Leu Val Asn Thr Met Ser Leu Arg Arg Tyr Leu Asp Glu
580                 585                 590                 595

gac gtt cac cgt cat att aac acg gac agc gat tct gag cta ctg ctt    2174
Asp Val His Arg His Ile Asn Thr Asp Ser Asp Ser Glu Leu Leu Leu
                600                 605                 610

aat ata ttt gcc gcg gag ctg gaa aag tac aac aaa tat cgt gtg aac    2222
Asn Ile Phe Ala Ala Glu Leu Glu Lys Tyr Asn Lys Tyr Arg Val Asn
            615                 620                 625

aac gat gat ata ttt tgt gct cta gag ggt gtt tac aaa cgt tgt cgc    2270
Asn Asp Asp Ile Phe Cys Ala Leu Glu Gly Val Tyr Lys Arg Cys Arg
        630                 635                 640
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ggt ggc tat gct tgt gtt ggc atg ttg gcg gga tat gga ttg ttt ggt      2318
Gly Gly Tyr Ala Cys Val Gly Met Leu Ala Gly Tyr Gly Leu Phe Gly
    645                 650                 655

ttc cgg gac ccc aat ggg atc agg ccg cta ttg ttt ggt gag cgc gtc      2366
Phe Arg Asp Pro Asn Gly Ile Arg Pro Leu Leu Phe Gly Glu Arg Val
660                 665                 670                 675

aac gat gac ggc acc atg gac tac atg cta gcg tcc gaa agt gtc gtt      2414
Asn Asp Asp Gly Thr Met Asp Tyr Met Leu Ala Ser Glu Ser Val Val
                680                 685                 690

ctt aag gcc cac cgc ttc caa aac ata cgt gat att ctt ccc ggc caa      2462
Leu Lys Ala His Arg Phe Gln Asn Ile Arg Asp Ile Leu Pro Gly Gln
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gcc gtc att atc cct aaa acg tgc ggc tcc agt cca cca gag ttc cgg      2510
Ala Val Ile Ile Pro Lys Thr Cys Gly Ser Ser Pro Pro Glu Phe Arg
        710                 715                 720

cag gta gtg cca att gag gcc tac aaa ccg gac ttg ttt gag tac gtg      2558
Gln Val Val Pro Ile Glu Ala Tyr Lys Pro Asp Leu Phe Glu Tyr Val
    725                 730                 735

tat ttc gct cgt gct gac agc gtt ctg gac ggt att tcc gtt tac cat      2606
Tyr Phe Ala Arg Ala Asp Ser Val Leu Asp Gly Ile Ser Val Tyr His
740                 745                 750                 755

aca cgc ctg ttg atg ggt atc aaa ctt gcc gag aac atc aaa aaa cag      2654
Thr Arg Leu Leu Met Gly Ile Lys Leu Ala Glu Asn Ile Lys Lys Gln
                760                 765                 770

atc gat ctg gac gaa att gac gtt gtt gta tct gtt cct gac act gca      2702
Ile Asp Leu Asp Glu Ile Asp Val Val Val Ser Val Pro Asp Thr Ala
            775                 780                 785

cgt acc tgt gca ttg gag tgt gcc aac cat tta aac aaa cct tat cgc      2750
Arg Thr Cys Ala Leu Glu Cys Ala Asn His Leu Asn Lys Pro Tyr Arg
        790                 795                 800

gaa gga ttt gtc aag aac aga tat gtt gga aga aca ttt atc atg cca      2798
Glu Gly Phe Val Lys Asn Arg Tyr Val Gly Arg Thr Phe Ile Met Pro
    805                 810                 815

aac caa aaa gag cga gta tct tct gtg cgc cgc aag ttg aac cca atg      2846
Asn Gln Lys Glu Arg Val Ser Ser Val Arg Arg Lys Leu Asn Pro Met
820                 825                 830                 835

aac tca gaa ttt aaa gac aag cgc gtg ctg att gtc gat gat tcc att      2894
Asn Ser Glu Phe Lys Asp Lys Arg Val Leu Ile Val Asp Asp Ser Ile
                840                 845                 850

gtg cga ggt acc act tcc aaa gag att gtt aac atg gcg aag gaa tcc      2942
Val Arg Gly Thr Thr Ser Lys Glu Ile Val Asn Met Ala Lys Glu Ser
            855                 860                 865

ggt gct gcc aag gtc tac ttt gcc tct gca gcg cca gca att cgt ttc      2990
Gly Ala Ala Lys Val Tyr Phe Ala Ser Ala Ala Pro Ala Ile Arg Phe
        870                 875                 880
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aat cac atc tac ggg att gac cta gca gat act aag cag ctt gtc gcc      3038
Asn His Ile Tyr Gly Ile Asp Leu Ala Asp Thr Lys Gln Leu Val Ala
    885                 890                 895

tac aac aga act gtt gaa gaa atc act gcg gag ctg ggc tgt gac cgc      3086
Tyr Asn Arg Thr Val Glu Glu Ile Thr Ala Glu Leu Gly Cys Asp Arg
900                 905                 910                 915

gtc atc tat caa tct ttg gat gac ctc atc gac tgt tgc aag aca gac      3134
Val Ile Tyr Gln Ser Leu Asp Asp Leu Ile Asp Cys Cys Lys Thr Asp
                920                 925                 930

atc atc tca gaa ttt gaa gtt gga gtt ttc act ggt aac tac gtt aca      3182
Ile Ile Ser Glu Phe Glu Val Gly Val Phe Thr Gly Asn Tyr Val Thr
            935                 940                 945

ggt gtt gag gat gtg tac ttg cag gaa tta gaa cgt tgc cgc gct ctt      3230
Gly Val Glu Asp Val Tyr Leu Gln Glu Leu Glu Arg Cys Arg Ala Leu
        950                 955                 960

aat aac tcg aat aag ggt gaa gcg aag gcc gag gtt gat att ggt ctc      3278
Asn Asn Ser Asn Lys Gly Glu Ala Lys Ala Glu Val Asp Ile Gly Leu
    965                 970                 975

tac aat tct gcc gac tat tagcggcgcc gttgccggca tccggcccca             3326
Tyr Asn Ser Ala Asp Tyr
980                 985

tatatagact catcgggacc taaaataagc ctttacagat cattatctac aaatatagat    3386

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ctttcttaaa tgccgttggt taggctttgg acttagcgtc ccgcccattt tctagcatgt    3506

gcagatctag caaatttggc ctaagacaag aagatccatt cggcacccac atcctggagc    3566

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                        Met Ser Ser Gly Asn Ile Trp Lys Gln Leu
                                        990                 995

cta gag gag aat agc gaa cag ctg gac cag tcc act acg gag act tac      3665
Leu Glu Glu Asn Ser Glu Gln Leu Asp Gln Ser Thr Thr Glu Thr Tyr
                1000                1005                1010

gtg gta tgc tgc gag aac gaa gat tcc ctt aac cag ttt ttg caa caa      3713
Val Val Cys Cys Glu Asn Glu Asp Ser Leu Asn Gln Phe Leu Gln Gln
            1015                1020                1025

tgt tgg cag att gac gag ggc gag aag gtg acc aac ctg gag ccg ttg      3761
Cys Trp Gln Ile Asp Glu Gly Glu Lys Val Thr Asn Leu Glu Pro Leu
        1030                1035                1040

gga ttc ttt aca aag gtg gtt tcg cgc gac gaa gag aac ctc cgg ctc      3809
Gly Phe Phe Thr Lys Val Val Ser Arg Asp Glu Glu Asn Leu Arg Leu
    1045                1050                1055

aac gta tac tat gcc aag agc cca ctg gat gca cag acg ctg cag ttt      3857
Asn Val Tyr Tyr Ala Lys Ser Pro Leu Asp Ala Gln Thr Leu Gln Phe
1060                1065                1070                1075
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ctg ggc gtg ttc ctg cgc caa atg gaa acc tca caa ata cgt tgg atc      3905
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                1080                1085                1090

ttc cta ctg gac tgg ctg cta gac gat aaa cga tta tgg cta cgt caa      3953
Phe Leu Leu Asp Trp Leu Leu Asp Asp Lys Arg Leu Trp Leu Arg Gln
            1095                1100                1105

ctg cgg aac tcg tgg gcc gcc ttg gag gaa gcg cag gtg gca ccc ttt      4001
Leu Arg Asn Ser Trp Ala Ala Leu Glu Glu Ala Gln Val Ala Pro Phe
        1110                1115                1120

cca ggt ggc gct gtg gtg gtg gtc ctc aac ccg agt cac gtg aca caa      4049
Pro Gly Gly Ala Val Val Val Val Leu Asn Pro Ser His Val Thr Gln
    1125                1130                1135

ctg gag cga aac acg atg gtt tgg aac tcc cgc cgt ctg gac ctg gta      4097
Leu Glu Arg Asn Thr Met Val Trp Asn Ser Arg Arg Leu Asp Leu Val
1140                1145                1150                1155

cac cag aca ctg cga gct gca tgc ctc aac acc ggc tcg gcg cta gtt      4145
His Gln Thr Leu Arg Ala Ala Cys Leu Asn Thr Gly Ser Ala Leu Val
                1160                1165                1170

aca ctt gat cct aat act gcg cgc gaa gac gtc atg cac ata tgt gcg      4193
Thr Leu Asp Pro Asn Thr Ala Arg Glu Asp Val Met His Ile Cys Ala
            1175                1180                1185

ctg ctt gcg ggg ctg cct aca tcc cgt ccc gtc gcg atg cta agc ctg      4241
Leu Leu Ala Gly Leu Pro Thr Ser Arg Pro Val Ala Met Leu Ser Leu
        1190                1195                1200

caa agt cta ttc atc ccc cac ggt gca gat tcc atc ggc aag atc tgc      4289
Gln Ser Leu Phe Ile Pro His Gly Ala Asp Ser Ile Gly Lys Ile Cys
    1205                1210                1215

acc atc gcg ccc gag ttc cct gtt gct acg gtg ttc gac aac gat ttt      4337
Thr Ile Ala Pro Glu Phe Pro Val Ala Thr Val Phe Asp Asn Asp Phe
1220                1225                1230                1235

gtg agc tcg aca ttc gag gcc gca att gct cca gaa ctt act cca gga      4385
Val Ser Ser Thr Phe Glu Ala Ala Ile Ala Pro Glu Leu Thr Pro Gly
                1240                1245                1250

cca cgt gtg cca tct gac cac cca tgg cta aca gag cct acc aac ccc      4433
Pro Arg Val Pro Ser Asp His Pro Trp Leu Thr Glu Pro Thr Asn Pro
            1255                1260                1265

cct tcg gag gca acc gct tgg cat ttc gat ctc caa ggt cgc ctc gct      4481
Pro Ser Glu Ala Thr Ala Trp His Phe Asp Leu Gln Gly Arg Leu Ala
        1270                1275                1280

acc cta tac cgg cat ctt ggt gac tct aac aag gcc ata tct gtt act      4529
Thr Leu Tyr Arg His Leu Gly Asp Ser Asn Lys Ala Ile Ser Val Thr
    1285                1290                1295

cag cac cgc ttc cac aag ccc cgc tcg gaa gat tat gca tac gaa ttc      4577
Gln His Arg Phe His Lys Pro Arg Ser Glu Asp Tyr Ala Tyr Glu Phe
1300                1305                1310                1315
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gag ctg ccg tct aag cac cct aca ata cgt gac ctc ata cgc tct gcc 4625
Glu Leu Pro Ser Lys His Pro Thr Ile Arg Asp Leu Ile Arg Ser Ala
1320 1325 1330

gca gcc gac tca ccg aac gac gtc gct gac tcc atc gat ggg ctt atg 4673
Ala Ala Asp Ser Pro Asn Asp Val Ala Asp Ser Ile Asp Gly Leu Met
1335 1340 1345

gat ggt atc gta caa agg aat gtt cat tgacgtcgac acaaaaattt 4720
Asp Gly Ile Val Gln Arg Asn Val His
1350 1355

tgttactgtt ctctcgagaa ctattctcat ccagtactga catattagaa ggcgaagtga 4780

actaggattt atataaagta gccttcaggc aattgcacag ggtctattga gtcgctgccg 4840

ttcacgagag agcccaatat atcgaggact aattggtcac ttttgttttg ctatactcac 4900

cctgtatttg ctaatcattt atccgctttg tccaagtggt tgcgaagata tcgagccaga 4960

acattagaat ctggtttgcc gcatcctaga gctgtctcca agccagttga accgttgcgg 5020

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35 40 45

Met Leu Leu Tyr Ser Ile Phe Thr Phe Arg Thr Thr Ala Trp Arg Thr
50 55 60

Arg Phe Arg Arg Asp Ala Asn Lys Ala Asp Asn Lys Ala Ala Ser Val
65 70 75 80

Ala Leu Asp Ser Leu Ile Asn Phe Glu Ala Val Lys Tyr Phe Asn Asn
85 90 95

Glu Lys Tyr Leu Ala Asp Lys Tyr His Thr Ser Leu Met Lys Tyr Arg
100 105 110

Asp Ser Gln Ile Lys Val Ser Gln Ser Leu Ala Phe Leu Asn Thr Gly
115 120 125

Gln Asn Leu Ile Phe Thr Thr Ala Leu Thr Ala Met Met Tyr Met Ala
130 135 140

Cys Asn Gly Val Met Gln Gly Ser Leu Thr Val Gly Asp Leu Val Leu
145 150 155 160

Ile Asn Gln Leu Val Phe Gln Leu Ser Val Pro Leu Asn Phe Leu Gly
165 170 175

Ser Val Tyr Arg Asp Leu Lys Gln Ser Leu Ile Asp Met Glu Ser Leu
180 185 190

Phe Lys Leu Gln Lys Asn Gln Val Thr Ile Lys Asn Ser Pro Asn Ala
195 200 205

Gln Asn Leu Pro Ile His Lys Pro Leu Asp Ile Arg Phe Glu Asn Val
210 215 220

Thr Phe Gly Tyr Asp Pro Glu Arg Arg Ile Leu Asn Asn Val Ser Phe
225 230 235 240

Thr Ile Pro Ala Gly Met Lys Thr Ala Ile Val Gly Pro Ser Gly Ser
245 250 255

Gly Lys Ser Thr Ile Leu Lys Leu Val Phe Arg Phe Tyr Glu Pro Glu
260 265 270

Gln Gly Arg Ile Leu Val Gly Gly Thr Asp Ile Arg Asp Leu Asp Leu
275 280 285

Leu Ser Leu Arg Lys Ala Ile Gly Val Val Pro Gln Asp Thr Pro Leu
290 295 300

Phe Asn Asp Thr Ile Trp Glu Asn Val Lys Phe Gly Asn Ile Ser Ser
305 310 315 320

Ser Asp Asp Glu Ile Leu Arg Ala Ile Glu Lys Ala Gln Leu Thr Lys
325 330 335

Leu Leu Gln Asn Leu Pro Lys Gly Ala Ser Thr Val Val Gly Glu Arg
340 345 350

Gly Leu Met Ile Ser Gly Gly Glu Lys Gln Arg Leu Ala Ile Ala Arg
355 360 365

Val Leu Leu Lys Asp Ala Pro Leu Met Phe Phe Asp Glu Ala Thr Ser
370 375 380

Ala Leu Asp Thr His Thr Glu Gln Ala Leu Leu His Thr Ile Gln Gln
385 390 395 400

Asn Phe Ser Ser Asn Ser Lys Thr Ser Val Tyr Val Ala His Arg Leu
405 410 415

Arg Thr Ile Ala Asp Ala Asp Lys Ile Ile Val Leu Glu Gln Gly Ser
420 425 430

Val Arg Glu Glu Gly Thr His Ser Ser Leu Leu Ala Ser Gln Gly Ser
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35 40 45

Cys Lys Gly Asn Gly Met Ala Arg Asp Val Phe Thr Gln Ala Arg Met
50 55 60

Ser Gly Leu Val Gly Ser Met Gly Ile Ala His Leu Arg Tyr Pro Thr
65 70 75 80

Ala Gly Ser Ser Ala Asn Ser Glu Ala Gln Pro Phe Tyr Val Asn Ser
85 90 95

Pro Tyr Gly Ile Cys Met Ser His Asn Gly Asn Leu Val Asn Thr Met
100 105 110

Ser Leu Arg Arg Tyr Leu Asp Glu Asp Val His Arg His Ile Asn Thr
115 120 125

Asp Ser Asp Ser Glu Leu Leu Leu Asn Ile Phe Ala Ala Glu Leu Glu
130 135 140

Lys Tyr Asn Lys Tyr Arg Val Asn Asn Asp Asp Ile Phe Cys Ala Leu
145 150 155 160

Glu Gly Val Tyr Lys Arg Cys Arg Gly Gly Tyr Ala Cys Val Gly Met
165 170 175

Leu Ala Gly Tyr Gly Leu Phe Gly Phe Arg Asp Pro Asn Gly Ile Arg
180 185 190

Pro Leu Leu Phe Gly Glu Arg Val Asn Asp Asp Gly Thr Met Asp Tyr
195 200 205

Met Leu Ala Ser Glu Ser Val Val Leu Lys Ala His Arg Phe Gln Asn
210 215 220

Ile Arg Asp Ile Leu Pro Gly Gln Ala Val Ile Ile Pro Lys Thr Cys
225 230 235 240

Gly Ser Ser Pro Pro Glu Phe Arg Gln Val Val Pro Ile Glu Ala Tyr
245 250 255

Lys Pro Asp Leu Phe Glu Tyr Val Tyr Phe Ala Arg Ala Asp Ser Val
260 265 270

Leu Asp Gly Ile Ser Val Tyr His Thr Arg Leu Leu Met Gly Ile Lys
275 280 285

Leu Ala Glu Asn Ile Lys Lys Gln Ile Asp Leu Asp Glu Ile Asp Val
290 295 300

Val Val Ser Val Pro Asp Thr Ala Arg Thr Cys Ala Leu Glu Cys Ala
305 310 315 320

Asn His Leu Asn Lys Pro Tyr Arg Glu Gly Phe Val Lys Asn Arg Tyr
325 330 335

Val Gly Arg Thr Phe Ile Met Pro Asn Gln Lys Glu Arg Val Ser Ser
340 345 350

Val Arg Arg Lys Leu Asn Pro Met Asn Ser Glu Phe Lys Asp Lys Arg
355 360 365

Val Leu Ile Val Asp Asp Ser Ile Val Arg Gly Thr Thr Ser Lys Glu
370 375 380

Ile Val Asn Met Ala Lys Glu Ser Gly Ala Ala Lys Val Tyr Phe Ala
385 390 395 400

Ser Ala Ala Pro Ala Ile Arg Phe Asn His Ile Tyr Gly Ile Asp Leu
405 410 415

Ala Asp Thr Lys Gln Leu Val Ala Tyr Asn Arg Thr Val Glu Glu Ile
420 425 430

Thr Ala Glu Leu Gly Cys Asp Arg Val Ile Tyr Gln Ser Leu Asp Asp
435 440 445

Leu Ile Asp Cys Cys Lys Thr Asp Ile Ile Ser Glu Phe Glu Val Gly
450 455 460

Val Phe Thr Gly Asn Tyr Val Thr Gly Val Glu Asp Val Tyr Leu Gln
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Glu Leu Glu Arg Cys Arg Ala Leu Asn Asn Ser Asn Lys Gly Glu Ala
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Lys Ala Glu Val Asp Ile Gly Leu Tyr Asn Ser Ala Asp Tyr
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35 40 45

Gly Glu Lys Val Thr Asn Leu Glu Pro Leu Gly Phe Phe Thr Lys Val
50 55 60

Val Ser Arg Asp Glu Glu Asn Leu Arg Leu Asn Val Tyr Tyr Ala Lys
65 70 75 80

Ser Pro Leu Asp Ala Gln Thr Leu Gln Phe Leu Gly Val Phe Leu Arg
85 90 95

Gln Met Glu Thr Ser Gln Ile Arg Trp Ile Phe Leu Leu Asp Trp Leu
100 105 110

Leu Asp Asp Lys Arg Leu Trp Leu Arg Gln Leu Arg Asn Ser Trp Ala
115 120 125

Ala Leu Glu Glu Ala Gln Val Ala Pro Phe Pro Gly Gly Ala Val Val
130 135 140

Val Val Leu Asn Pro Ser His Val Thr Gln Leu Glu Arg Asn Thr Met
145 150 155 160

Val Trp Asn Ser Arg Arg Leu Asp Leu Val His Gln Thr Leu Arg Ala
165 170 175

Ala Cys Leu Asn Thr Gly Ser Ala Leu Val Thr Leu Asp Pro Asn Thr
180 185 190

Ala Arg Glu Asp Val Met His Ile Cys Ala Leu Leu Ala Gly Leu Pro
195 200 205

Thr Ser Arg Pro Val Ala Met Leu Ser Leu Gln Ser Leu Phe Ile Pro
210 215 220

His Gly Ala Asp Ser Ile Gly Lys Ile Cys Thr Ile Ala Pro Glu Phe
225 230 235 240

Pro Val Ala Thr Val Phe Asp Asn Asp Phe Val Ser Ser Thr Phe Glu
245 250 255

Ala Ala Ile Ala Pro Glu Leu Thr Pro Gly Pro Arg Val Pro Ser Asp
260 265 270

His Pro Trp Leu Thr Glu Pro Thr Asn Pro Pro Ser Glu Ala Thr Ala

275 280 285

Trp His Phe Asp Leu Gln Gly Arg Leu Ala Thr Leu Tyr Arg His Leu
290 295 300

Gly Asp Ser Asn Lys Ala Ile Ser Val Thr Gln His Arg Phe His Lys
305 310 315 320

Pro Arg Ser Glu Asp Tyr Ala Tyr Glu Phe Glu Leu Pro Ser Lys His
325 330 335

Pro Thr Ile Arg Asp Leu Ile Arg Ser Ala Ala Ala Asp Ser Pro Asn
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Asp Val Ala Asp Ser Ile Asp Gly Leu Met Asp Gly Ile Val Gln Arg
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Asn Val His
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ccgattacta cagctacgtg ctggatgtga acttcgcgct gctgagcgcc atgagcgcga 180

ccggcctcgc gatgggcgcc gtgagcggct ccctcgggag cgcgccggtg ctcgcgcagt 240

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catagcacgc cgaacaaagc gca atg act tac aga gac gca gcc acg gca           890
                         Met Thr Tyr Arg Asp Ala Ala Thr Ala
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ctg gag cac ctg gcg acg tac gcc gag aag gac ggg ctg tcc gtg gag        938
Leu Glu His Leu Ala Thr Tyr Ala Glu Lys Asp Gly Leu Ser Val Glu
 10                  15                  20                  25

cag ttg atg gac tcc aag acg cgg ggc ggg ttg acg tac aac gac ttc        986
Gln Leu Met Asp Ser Lys Thr Arg Gly Gly Leu Thr Tyr Asn Asp Phe
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ctg gtc ttg ccg ggc aag atc gac ttc cca tcg tcg gag gtg gtg ctg       1034
Leu Val Leu Pro Gly Lys Ile Asp Phe Pro Ser Ser Glu Val Val Leu
             45                  50                  55

tcg tcg cgc ctg acc aag aag atc acc ttg aac gcg ccg ttt gtg tcg       1082
Ser Ser Arg Leu Thr Lys Lys Ile Thr Leu Asn Ala Pro Phe Val Ser
         60                  65                  70

tcg ccg atg gac acg gtg acg gag gcc gac atg gcg atc cac atg gcg       1130
Ser Pro Met Asp Thr Val Thr Glu Ala Asp Met Ala Ile His Met Ala
     75                  80                  85

ctc ctg ggc ggc atc ggg atc atc cac cac aac tgc act gcg gag gag       1178
Leu Leu Gly Gly Ile Gly Ile Ile His His Asn Cys Thr Ala Glu Glu
 90                  95                 100                 105

cag gcg gag atg gtg cgc cgg gtc aag aag tac gaa aac ggg ttc atc       1226
Gln Ala Glu Met Val Arg Arg Val Lys Lys Tyr Glu Asn Gly Phe Ile
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aac gcc ccc gtg gtc gtg ggg ccg gac gcg acg gtg gcg gac gtg cgc       1274
Asn Ala Pro Val Val Val Gly Pro Asp Ala Thr Val Ala Asp Val Arg
            125                 130                 135

cgg atg aag aac gag ttt ggg ttt gca gga ttt cct gtg aca               1316
Arg Met Lys Asn Glu Phe Gly Phe Ala Gly Phe Pro Val Thr
        140                 145                 150

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tcgttctact gactgcgatc aaacgatcgt gtagacacct tttactctga ccgcagacgt     1436

gcagcgcctt tttggcagga acatgtacta acacatcagc a gat gat ggc aag          1489
                                              Asp Asp Gly Lys
                                                155

ccg acc ggg aag ctg cag ggg atc atc acg tcc cgt gac atc cag ttt       1537
Pro Thr Gly Lys Leu Gln Gly Ile Ile Thr Ser Arg Asp Ile Gln Phe
            160                 165                 170

gtc gag gac gag acc ctg ctt gtg tct gag atc atg acc aag gac gtc       1585
Val Glu Asp Glu Thr Leu Leu Val Ser Glu Ile Met Thr Lys Asp Val
        175                 180                 185
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atc act ggg aag cag ggc atc aac ctc gag gag gcg aac cag atc ctg      1633
Ile Thr Gly Lys Gln Gly Ile Asn Leu Glu Glu Ala Asn Gln Ile Leu
        190                 195                 200

aag aac acc aag aag ggc aag ctg cca att gtg gac gag gcg ggc tgc      1681
Lys Asn Thr Lys Lys Gly Lys Leu Pro Ile Val Asp Glu Ala Gly Cys
    205                 210                 215

ctg gtg tcc atg ctt tcg aga act gac ttg atg aag aac cag tcc tac      1729
Leu Val Ser Met Leu Ser Arg Thr Asp Leu Met Lys Asn Gln Ser Tyr
220                 225                 230                 235

cca ttg gcc tcc aag tct gcc gac acc aag cag ctg ctc tgt ggt gct      1777
Pro Leu Ala Ser Lys Ser Ala Asp Thr Lys Gln Leu Leu Cys Gly Ala
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gcg atc ggc acc atc gac gcg gac agg cag aga ctg gcg atg ctg gtc      1825
Ala Ile Gly Thr Ile Asp Ala Asp Arg Gln Arg Leu Ala Met Leu Val
            255                 260                 265

gag gcc ggt ctg gac gtt gtt gtg cta gac tcc tcg cag ggt aac tcg      1873
Glu Ala Gly Leu Asp Val Val Val Leu Asp Ser Ser Gln Gly Asn Ser
        270                 275                 280

gtc ttc cag atc aac atg atc aag tgg atc aag gag acc ttc cca gac      1921
Val Phe Gln Ile Asn Met Ile Lys Trp Ile Lys Glu Thr Phe Pro Asp
    285                 290                 295

ctg cag gtc att gct ggc aac gtg gtc acc aga gag cag gct gcc agc      1969
Leu Gln Val Ile Ala Gly Asn Val Val Thr Arg Glu Gln Ala Ala Ser
300                 305                 310                 315

ttg atc cac gcc ggc gca gac ggg ttg cgt atc ggt atg ggc tct ggc      2017
Leu Ile His Ala Gly Ala Asp Gly Leu Arg Ile Gly Met Gly Ser Gly
                320                 325                 330

tcc atc tgt atc act cag gag gtg atg gcc tgt ggt aga cca cag ggt      2065
Ser Ile Cys Ile Thr Gln Glu Val Met Ala Cys Gly Arg Pro Gln Gly
            335                 340                 345

acc gct gtc tac aac gtc acg cag ttc gcc aac cag ttt ggt gtg cca      2113
Thr Ala Val Tyr Asn Val Thr Gln Phe Ala Asn Gln Phe Gly Val Pro
        350                 355                 360

tgt att gct gac ggt ggt gtc cag aac atc ggg cac att acc aaa gct      2161
Cys Ile Ala Asp Gly Gly Val Gln Asn Ile Gly His Ile Thr Lys Ala
    365                 370                 375

atc gct ctt ggc gcg tcc acc gtc atg atg ggc ggt atg ctg gca ggc      2209
Ile Ala Leu Gly Ala Ser Thr Val Met Met Gly Gly Met Leu Ala Gly
380                 385                 390                 395

act aca gag tct cca ggc gag tac ttc ttc agg gac ggg aag aga ctg      2257
Thr Thr Glu Ser Pro Gly Glu Tyr Phe Phe Arg Asp Gly Lys Arg Leu
                400                 405                 410

aag acc tac aga ggt atg ggc tcc atc gac gcc atg caa aag act gat      2305
Lys Thr Tyr Arg Gly Met Gly Ser Ile Asp Ala Met Gln Lys Thr Asp
            415                 420                 425
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gtc aag ggt aac gcc gct acc tcc cgt tac ttc tct gag tct gac aag      2353
Val Lys Gly Asn Ala Ala Thr Ser Arg Tyr Phe Ser Glu Ser Asp Lys
        430                 435                 440

gtt ctg gtc gct cag ggt gtt act ggt tct gtg atc gac aag ggc tcc      2401
Val Leu Val Ala Gln Gly Val Thr Gly Ser Val Ile Asp Lys Gly Ser
    445                 450                 455

atc aag aag tac att cca tat ctg tac aat ggt cta cag cac tcg tgc      2449
Ile Lys Lys Tyr Ile Pro Tyr Leu Tyr Asn Gly Leu Gln His Ser Cys
460                 465                 470                 475

cag gat atc ggt gtg cgc tct cta gtg gag ttc aga gag aag gtg gac      2497
Gln Asp Ile Gly Val Arg Ser Leu Val Glu Phe Arg Glu Lys Val Asp
                480                 485                 490

tct ggc tcg gtc aga ttt gag ttc aga act cca tct gcc cag ttg gag      2545
Ser Gly Ser Val Arg Phe Glu Phe Arg Thr Pro Ser Ala Gln Leu Glu
            495                 500                 505

ggt ggt gtg cac aac ttg cac tcc tac gag aag cgc cta ttt gactgagtgc   2597
Gly Gly Val His Asn Leu His Ser Tyr Glu Lys Arg Leu Phe Asp
        510                 515                 520

cactaggccc acactataga agtggatccg ggcgcgatgg cacccatact tttatattat   2657

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tgggacactt ggtgagatat atgtttcatt atgtatgcct cgctatcgaa aggtctggca   2837

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gtccagaata gaccgttttt tcttcgattt cttggagcca ggtataacag ttacaacctg   3257

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gccaacaaat ggcaaagacc aggtgaatac gtccatgaaa ttcggtaacc aatacggatg   3437

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cttgttcttg taagtgtcca agtagttggg tgcgctgaac aacgtaagta aactaggaaa   3557

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20 25 30

Arg Gly Gly Leu Thr Tyr Asn Asp Phe Leu Val Leu Pro Gly Lys Ile
35 40 45

Asp Phe Pro Ser Ser Glu Val Val Leu Ser Ser Arg Leu Thr Lys Lys
50 55 60

Ile Thr Leu Asn Ala Pro Phe Val Ser Ser Pro Met Asp Thr Val Thr
65 70 75 80

Glu Ala Asp Met Ala Ile His Met Ala Leu Leu Gly Gly Ile Gly Ile
85 90 95

Ile His His Asn Cys Thr Ala Glu Glu Gln Ala Glu Met Val Arg Arg
100 105 110

Val Lys Lys Tyr Glu Asn Gly Phe Ile Asn Ala Pro Val Val Val Gly
115 120 125

Pro Asp Ala Thr Val Ala Asp Val Arg Arg Met Lys Asn Glu Phe Gly
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Phe Ala Gly Phe Pro Val Thr
145 150

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Asp Ile Gln Phe Val Glu Asp Glu Thr Leu Leu Val Ser Glu Ile Met
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35 40 45

Asn Gln Ile Leu Lys Asn Thr Lys Lys Gly Lys Leu Pro Ile Val Asp
50 55 60

Glu Ala Gly Cys Leu Val Ser Met Leu Ser Arg Thr Asp Leu Met Lys
65 70 75 80

Asn Gln Ser Tyr Pro Leu Ala Ser Lys Ser Ala Asp Thr Lys Gln Leu
85 90 95

Leu Cys Gly Ala Ala Ile Gly Thr Ile Asp Ala Asp Arg Gln Arg Leu
100 105 110

Ala Met Leu Val Glu Ala Gly Leu Asp Val Val Val Leu Asp Ser Ser
115 120 125

Gln Gly Asn Ser Val Phe Gln Ile Asn Met Ile Lys Trp Ile Lys Glu
130 135 140

Thr Phe Pro Asp Leu Gln Val Ile Ala Gly Asn Val Val Thr Arg Glu
145 150 155 160

Gln Ala Ala Ser Leu Ile His Ala Gly Ala Asp Gly Leu Arg Ile Gly
165 170 175

Met Gly Ser Gly Ser Ile Cys Ile Thr Gln Glu Val Met Ala Cys Gly
180 185 190

Arg Pro Gln Gly Thr Ala Val Tyr Asn Val Thr Gln Phe Ala Asn Gln
195 200 205

Phe Gly Val Pro Cys Ile Ala Asp Gly Gly Val Gln Asn Ile Gly His
210 215 220

Ile Thr Lys Ala Ile Ala Leu Gly Ala Ser Thr Val Met Met Gly Gly
225 230 235 240

Met Leu Ala Gly Thr Thr Glu Ser Pro Gly Glu Tyr Phe Phe Arg Asp
245 250 255

Gly Lys Arg Leu Lys Thr Tyr Arg Gly Met Gly Ser Ile Asp Ala Met
260 265 270

Gln Lys Thr Asp Val Lys Gly Asn Ala Ala Thr Ser Arg Tyr Phe Ser
275 280 285

Glu Ser Asp Lys Val Leu Val Ala Gln Gly Val Thr Gly Ser Val Ile
290 295 300

Asp Lys Gly Ser Ile Lys Lys Tyr Ile Pro Tyr Leu Tyr Asn Gly Leu
305 310 315 320

Gln His Ser Cys Gln Asp Ile Gly Val Arg Ser Leu Val Glu Phe Arg
325 330 335

Glu Lys Val Asp Ser Gly Ser Val Arg Phe Glu Phe Arg Thr Pro Ser
340 345 350

Ala Gln Leu Glu Gly Gly Val His Asn Leu His Ser Tyr Glu Lys Arg
355 360 365

Leu Phe Asp
370

<210> 10
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<212> DNA
<213> Ashbya gossypii

<220>
<221> CDS
<222> 456..2033

<400> 10

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cgacgatttg cacgcgcaga agagggcgtt caaccagcct ttcggatatt ccggttcgag 120

ttataccagc agggatcagc gcaggcacta gagtggcggg tgctaataag aggagcaggt 180

cctggaactg aagttgcaag agataagcat tgcgcggaga aggaggcggt tagagggtgc 240

aagcgagcag gatggggtct tcgatgaact tcccgtctgg gtatgtgaac aagcacacgc 300

tgcaggcaca ccggtagggc gagtgcaggg tgaaaaatat atatgcgctc gagaagcgct 360

ggggatgagt tcgtctgcaa cggcaggcgg atcttcatct gacaaaacca gctgcctaca 420

tcagtgcgaa gctgttcagt gatagaatag gagta atg gct gct gtt gaa caa 473
Met Ala Ala Val Glu Gln
1 5

gtt tct agc gtg ttt gac acc att ttg gtg ctg gac ttc ggg tcc cag 521
Val Ser Ser Val Phe Asp Thr Ile Leu Val Leu Asp Phe Gly Ser Gln
10 15 20

tac tcg cat ctg atc acg cgg cgg ctg cgt gag ttt aat gtg tac gcg 569
Tyr Ser His Leu Ile Thr Arg Arg Leu Arg Glu Phe Asn Val Tyr Ala
25 30 35

gag atg ctt ccg tgt acg cag aag atc agc gag ctg ggc tgg aag cca 617
Glu Met Leu Pro Cys Thr Gln Lys Ile Ser Glu Leu Gly Trp Lys Pro
40 45 50

aag ggt gtg att ttg tca ggc ggg ccg tac tcc gtg tac gcg gca gat 665
Lys Gly Val Ile Leu Ser Gly Gly Pro Tyr Ser Val Tyr Ala Ala Asp
55 60 65 70

gct ccg cac gtg gac cgg gcg gtg ttc gag ttg ggc gtt cca att ctg 713
Ala Pro His Val Asp Arg Ala Val Phe Glu Leu Gly Val Pro Ile Leu
75 80 85

ggc atc tgc tac ggg cta cag gag ctt gcg tgg ata gcc ggc gca gag 761
Gly Ile Cys Tyr Gly Leu Gln Glu Leu Ala Trp Ile Ala Gly Ala Glu
90 95 100

gtg ggg cgc ggc gag aag cgc gag tac ggg cgc gcg acg ctg cac gtg 809
Val Gly Arg Gly Glu Lys Arg Glu Tyr Gly Arg Ala Thr Leu His Val
105 110 115

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gag gac agc gcg tgc ccg ctg ttc aac aac gtg gac agc agc acg gtg        857
Glu Asp Ser Ala Cys Pro Leu Phe Asn Asn Val Asp Ser Ser Thr Val
    120                 125                 130

tgg atg tcg cac ggt gac aag ctg cac gca cta cct gcg gat ttc cac        905
Trp Met Ser His Gly Asp Lys Leu His Ala Leu Pro Ala Asp Phe His
135                 140                 145                 150

gtc act gcg acg acg gag aac tct cct ttc tgc ggg att gca cac gac        953
Val Thr Ala Thr Thr Glu Asn Ser Pro Phe Cys Gly Ile Ala His Asp
                155                 160                 165

tcg aag cca atc ttc ggg atc cag ttc cac cct gag gtg acg cac tcc       1001
Ser Lys Pro Ile Phe Gly Ile Gln Phe His Pro Glu Val Thr His Ser
            170                 175                 180

tcg cag ggg aag acg ttg ctg aag aac ttt gcg gtg gag atc tgc cag       1049
Ser Gln Gly Lys Thr Leu Leu Lys Asn Phe Ala Val Glu Ile Cys Gln
        185                 190                 195

gcc gcg cag acc tgg acg atg gaa aac ttc att gac acc gag atc cag       1097
Ala Ala Gln Thr Trp Thr Met Glu Asn Phe Ile Asp Thr Glu Ile Gln
    200                 205                 210

cgg atc cgg acc ctt gtg ggc ccc acc gcg gaa gtc atc ggt gct gtg       1145
Arg Ile Arg Thr Leu Val Gly Pro Thr Ala Glu Val Ile Gly Ala Val
215                 220                 225                 230

tcc ggc ggt gtc gac tcg acc gtc gct gcg aag ctg atg acc gag gcc       1193
Ser Gly Gly Val Asp Ser Thr Val Ala Ala Lys Leu Met Thr Glu Ala
                235                 240                 245

atc ggc gac cgg ttc cac gcg atc ctg gtc gac aac ggt gtt ctg cgc       1241
Ile Gly Asp Arg Phe His Ala Ile Leu Val Asp Asn Gly Val Leu Arg
            250                 255                 260

ctc aac gaa gcg gcc aat gtg aag aaa atc ctc ggc gag ggc ttg ggc       1289
Leu Asn Glu Ala Ala Asn Val Lys Lys Ile Leu Gly Glu Gly Leu Gly
        265                 270                 275

atc aac ttg act gtt gtt gac gcc tcc gaa gag ttc ttg acg aag ctc       1337
Ile Asn Leu Thr Val Val Asp Ala Ser Glu Glu Phe Leu Thr Lys Leu
    280                 285                 290

aag ggc gtc acg gac cct gag aag aag aga aag atc atc ggt aac acc       1385
Lys Gly Val Thr Asp Pro Glu Lys Lys Arg Lys Ile Ile Gly Asn Thr
295                 300                 305                 310

ttc att cat gtt ttt gag cgc gag gca gcc agg atc cag cct aag aac       1433
Phe Ile His Val Phe Glu Arg Glu Ala Ala Arg Ile Gln Pro Lys Asn
                315                 320                 325

ggc gag gag att gag ttc ctg ttg cag ggt acc cta tac cct gac gtt       1481
Gly Glu Glu Ile Glu Phe Leu Leu Gln Gly Thr Leu Tyr Pro Asp Val
            330                 335                 340

atc gag tcc att tcc ttt aag ggc cca tct cag acg atc aag acc cac       1529
Ile Glu Ser Ile Ser Phe Lys Gly Pro Ser Gln Thr Ile Lys Thr His
        345                 350                 355
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cat aac gtc ggt ggt ctt ttg gac aac atg aaa ctg aag ctc att gag      1577
His Asn Val Gly Gly Leu Leu Asp Asn Met Lys Leu Lys Leu Ile Glu
    360                 365                 370

cct ttg cgc gag ctt ttc aag gac gag gtg aga cac ctg gga gaa cta      1625
Pro Leu Arg Glu Leu Phe Lys Asp Glu Val Arg His Leu Gly Glu Leu
375                 380                 385                 390

ttg ggg atc tcc cac gag ttg gtc tgg aga cat ccg ttc cca ggc cca      1673
Leu Gly Ile Ser His Glu Leu Val Trp Arg His Pro Phe Pro Gly Pro
                395                 400                 405

ggt atc gcc atc cgt gtg cta ggc gag gtc acc aag gag cag gtg gag      1721
Gly Ile Ala Ile Arg Val Leu Gly Glu Val Thr Lys Glu Gln Val Glu
            410                 415                 420

att gcc aga aag gca gac cac atc tac atc gag gag atc agg aaa gca      1769
Ile Ala Arg Lys Ala Asp His Ile Tyr Ile Glu Glu Ile Arg Lys Ala
        425                 430                 435

ggt cta tac aac aag att tct caa gct ttt gct tgc ttg ctg cct gtt      1817
Gly Leu Tyr Asn Lys Ile Ser Gln Ala Phe Ala Cys Leu Leu Pro Val
    440                 445                 450

aag tct gtg ggt gtc atg ggt gac cag aga acc tac gac cag gtc att      1865
Lys Ser Val Gly Val Met Gly Asp Gln Arg Thr Tyr Asp Gln Val Ile
455                 460                 465                 470

gct cta aga gca att gag acc acg gac ttc atg act gcc gac tgg tat      1913
Ala Leu Arg Ala Ile Glu Thr Thr Asp Phe Met Thr Ala Asp Trp Tyr
                475                 480                 485

cca ttt gag cac gaa ttc ttg aag cat gtc gca tcc cgt att gtt aac      1961
Pro Phe Glu His Glu Phe Leu Lys His Val Ala Ser Arg Ile Val Asn
            490                 495                 500

gag gtt gaa ggt gtt gcc aga gtc acc tac gac ata act tct aag cct      2009
Glu Val Glu Gly Val Ala Arg Val Thr Tyr Asp Ile Thr Ser Lys Pro
        505                 510                 515

cca gct acc gtt gaa tgg gaa taatcaccct tgggatccgc tgactggcta         2060
Pro Ala Thr Val Glu Trp Glu
    520                 525

ctgtaattct atgtagtgga ttagtacgat aagttacttt tgtatgatag atgtaatcac    2120

atctggctat taaaatgact cagccgaggt aaatctaacg tcccttcaca agggtgttcc    2180

tgtgtggact tccgcctgaa tttttataga tatatagata ctctactcat gaacaacctg    2240

caaccgaata agcattagtg ccaggagaag agaaccgtgg aaatggggca agtagaaaaa    2300

atcatattcc ttaagaataa gacagtacca gaggaccatt acgagacgat ttttgaatcg    2360

aatggcttcc agactcactt tgtacccata ataacccatg aacacctgcc agatgaggtt    2420

cgcggtcgac tatccgacgc gaattacatg aaaaggttga attgtttggt ggtaacctct    2480

cagaggactg tggagtgtct ctatgaggac gttctgccct ctcttccagc tgaagcacgc    2540
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aaatctcttc tcaatacgcc agtattcgtg gttgggcgtg ccactcagga atttatggag 2600

agatgcggct ttacggacgt gagaggggga tctgagactg gtaatggcgt tttgctagcg 2660

gagttaatgt taaatatgat ccagaagggc gatgggg 2697

<210> 11
<211> 525
<212> PRT
<213> Ashbya gossypii

<400> 11

Met Ala Ala Val Glu Gln Val Ser Ser Val Phe Asp Thr Ile Leu Val
1 5 10 15

Leu Asp Phe Gly Ser Gln Tyr Ser His Leu Ile Thr Arg Arg Leu Arg
20 25 30

Glu Phe Asn Val Tyr Ala Glu Met Leu Pro Cys Thr Gln Lys Ile Ser
35 40 45

Glu Leu Gly Trp Lys Pro Lys Gly Val Ile Leu Ser Gly Gly Pro Tyr
50 55 60

Ser Val Tyr Ala Ala Asp Ala Pro His Val Asp Arg Ala Val Phe Glu
65 70 75 80

Leu Gly Val Pro Ile Leu Gly Ile Cys Tyr Gly Leu Gln Glu Leu Ala
85 90 95

Trp Ile Ala Gly Ala Glu Val Gly Arg Gly Glu Lys Arg Glu Tyr Gly
100 105 110

Arg Ala Thr Leu His Val Glu Asp Ser Ala Cys Pro Leu Phe Asn Asn
115 120 125

Val Asp Ser Ser Thr Val Trp Met Ser His Gly Asp Lys Leu His Ala
130 135 140

Leu Pro Ala Asp Phe His Val Thr Ala Thr Thr Glu Asn Ser Pro Phe
145 150 155 160

Cys Gly Ile Ala His Asp Ser Lys Pro Ile Phe Gly Ile Gln Phe His
165 170 175

Pro Glu Val Thr His Ser Ser Gln Gly Lys Thr Leu Leu Lys Asn Phe
180 185 190

Ala Val Glu Ile Cys Gln Ala Ala Gln Thr Trp Thr Met Glu Asn Phe
195 200 205

Ile Asp Thr Glu Ile Gln Arg Ile Arg Thr Leu Val Gly Pro Thr Ala
210 215 220

Glu Val Ile Gly Ala Val Ser Gly Gly Val Asp Ser Thr Val Ala Ala

225 230 235 240

Lys Leu Met Thr Glu Ala Ile Gly Asp Arg Phe His Ala Ile Leu Val
245 250 255

Asp Asn Gly Val Leu Arg Leu Asn Glu Ala Ala Asn Val Lys Lys Ile
260 265 270

Leu Gly Glu Gly Leu Gly Ile Asn Leu Thr Val Val Asp Ala Ser Glu
275 280 285

Glu Phe Leu Thr Lys Leu Lys Gly Val Thr Asp Pro Glu Lys Lys Arg
290 295 300

Lys Ile Ile Gly Asn Thr Phe Ile His Val Phe Glu Arg Glu Ala Ala
305 310 315 320

Arg Ile Gln Pro Lys Asn Gly Glu Glu Ile Glu Phe Leu Leu Gln Gly
325 330 335

Thr Leu Tyr Pro Asp Val Ile Glu Ser Ile Ser Phe Lys Gly Pro Ser
340 345 350

Gln Thr Ile Lys Thr His His Asn Val Gly Gly Leu Leu Asp Asn Met
355 360 365

Lys Leu Lys Leu Ile Glu Pro Leu Arg Glu Leu Phe Lys Asp Glu Val
370 375 380

Arg His Leu Gly Glu Leu Leu Gly Ile Ser His Glu Leu Val Trp Arg
385 390 395 400

His Pro Phe Pro Gly Pro Gly Ile Ala Ile Arg Val Leu Gly Glu Val
405 410 415

Thr Lys Glu Gln Val Glu Ile Ala Arg Lys Ala Asp His Ile Tyr Ile
420 425 430

Glu Glu Ile Arg Lys Ala Gly Leu Tyr Asn Lys Ile Ser Gln Ala Phe
435 440 445

Ala Cys Leu Leu Pro Val Lys Ser Val Gly Val Met Gly Asp Gln Arg
450 455 460

Thr Tyr Asp Gln Val Ile Ala Leu Arg Ala Ile Glu Thr Thr Asp Phe
465 470 475 480

Met Thr Ala Asp Trp Tyr Pro Phe Glu His Glu Phe Leu Lys His Val
485 490 495

Ala Ser Arg Ile Val Asn Glu Val Glu Gly Val Ala Arg Val Thr Tyr
500 505 510

Asp Ile Thr Ser Lys Pro Pro Ala Thr Val Glu Trp Glu
515 520 525

<210> 12
<211> 1634
<212> DNA
<213> Ashbya gossypii

<220>
<221> CDS
<222> 520..1482

<400> 12

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atgttacggg atgtccctga cgccacagaa ggtagcctgg tggtccagac agaaaaagag 180

cctacaccaa agaagaaaca taacaagaaa aagcctccgc atcgttttgg taaatcataa 240

taggcacgat gcgcatatac cctgaccatc atagcggttc cccccgctaa ctgctccgag 300

cgggtaaccc catgtcacaa agtgactctg tctcttcgtg gtaggtgatg tcaaattttc 360

acgacttccc accccgatga gcatccgtat tccttttcat ctaaattcta atagatggct 420

tatggattct tattggcgac ttacaagcct atgtagttgg cttccctcaa gtgttcgtag 480

tctaccacct cacacccggt ctaacagctt acgagaata atg gct act aat gca 534
Met Ala Thr Asn Ala
1 5

atc aag ctt ctt gcg cca gat atc cac agg ggt ctg gca gag ctg gtc 582
Ile Lys Leu Leu Ala Pro Asp Ile His Arg Gly Leu Ala Glu Leu Val
10 15 20

gct aaa cgc cta ggc tta cgt ctg aca gac tgc aag ctt aag cgg gat 630
Ala Lys Arg Leu Gly Leu Arg Leu Thr Asp Cys Lys Leu Lys Arg Asp
25 30 35

tgt aac ggg gag gcg aca ttt tcg atc gga gaa tct gtt cga gac cag 678
Cys Asn Gly Glu Ala Thr Phe Ser Ile Gly Glu Ser Val Arg Asp Gln
40 45 50

gat atc tac atc atc acg cag gtg ggg tcc ggg gac gtg aac gac cga 726
Asp Ile Tyr Ile Ile Thr Gln Val Gly Ser Gly Asp Val Asn Asp Arg
55 60 65

gtg ctg gag ctg ctc atc atg atc aac gct agc aag acg gcg tct gcg 774
Val Leu Glu Leu Leu Ile Met Ile Asn Ala Ser Lys Thr Ala Ser Ala
70 75 80 85

cgg cga att acg gct gtg att cca aac ttc cca tac gcg cgg cag gac 822
Arg Arg Ile Thr Ala Val Ile Pro Asn Phe Pro Tyr Ala Arg Gln Asp
90 95 100

cgg aag gat aag tca cgg gcg cca att acc gcg aag ctc atg gcg gac 870
Arg Lys Asp Lys Ser Arg Ala Pro Ile Thr Ala Lys Leu Met Ala Asp
105 110 115

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atg ctg act acc gcg ggc tgc gat cat gtc atc acc atg gac tta cac        918
Met Leu Thr Thr Ala Gly Cys Asp His Val Ile Thr Met Asp Leu His
        120                 125                 130

gct tcg caa atc cag ggc ttc ttt gat gta cca gtt gac aac ctt tac        966
Ala Ser Gln Ile Gln Gly Phe Phe Asp Val Pro Val Asp Asn Leu Tyr
    135                 140                 145

gca gag cct agc gtg gtg aag tat atc aag gag cat att ccc cac gac       1014
Ala Glu Pro Ser Val Val Lys Tyr Ile Lys Glu His Ile Pro His Asp
150                 155                 160                 165

gat gcc atc atc atc tcg ccg gat gct ggt ggt gcc aaa cgt gcg tcg       1062
Asp Ala Ile Ile Ile Ser Pro Asp Ala Gly Gly Ala Lys Arg Ala Ser
                170                 175                 180

ctt cta tca gat cgc cta aac ttg aac ttt gcg ctg att cat aag gaa       1110
Leu Leu Ser Asp Arg Leu Asn Leu Asn Phe Ala Leu Ile His Lys Glu
            185                 190                 195

cgt gca aag gca aac gaa gtg tcc cgc atg gtt ctg gtc ggc gat gtt       1158
Arg Ala Lys Ala Asn Glu Val Ser Arg Met Val Leu Val Gly Asp Val
        200                 205                 210

acc gat aaa gtc tgc att atc gtt gac gat atg gcg gat act tgt ggt       1206
Thr Asp Lys Val Cys Ile Ile Val Asp Asp Met Ala Asp Thr Cys Gly
    215                 220                 225

acg ctg gcc aag gcg gca gaa gtg ctg cta gag cac aac gcg cgg tct       1254
Thr Leu Ala Lys Ala Ala Glu Val Leu Leu Glu His Asn Ala Arg Ser
230                 235                 240                 245

gtg ata gcc att gtt acc cac ggt atc ctt tca gga aag gcc att gag       1302
Val Ile Ala Ile Val Thr His Gly Ile Leu Ser Gly Lys Ala Ile Glu
                250                 255                 260

aac atc aac aat tcg aag ctt gat agg gtt gtg tgt acc aac acc gtg       1350
Asn Ile Asn Asn Ser Lys Leu Asp Arg Val Val Cys Thr Asn Thr Val
            265                 270                 275

cca ttc gag gag aag atg aag tta tgc ccg aag tta gat gta att gat       1398
Pro Phe Glu Glu Lys Met Lys Leu Cys Pro Lys Leu Asp Val Ile Asp
        280                 285                 290

atc tcg gca gtt ctt gcg gaa tcc att cgc cgt cta cac aat ggt gaa       1446
Ile Ser Ala Val Leu Ala Glu Ser Ile Arg Arg Leu His Asn Gly Glu
    295                 300                 305

agt atc tcc tac ctc ttt aaa aac aac cca cta tgattttgct tctcgatgct     1499
Ser Ile Ser Tyr Leu Phe Lys Asn Asn Pro Leu
310                 315                 320

ggcttcttga gggccaattt tgccgtagag gtagtatccc ttctttttat attgactatt     1559

taacgaagac tatttcttca taaatggact tcggcttcac tgtgaatctc acatgatata     1619

gttgtttcag agacc                                                     1634
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<211> 320
<212> PRT
<213> Ashbya gossypii

<400> 13

Met Ala Thr Asn Ala Ile Lys Leu Leu Ala Pro Asp Ile His Arg Gly
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20 25 30

Lys Leu Lys Arg Asp Cys Asn Gly Glu Ala Thr Phe Ser Ile Gly Glu
35 40 45

Ser Val Arg Asp Gln Asp Ile Tyr Ile Ile Thr Gln Val Gly Ser Gly
50 55 60

Asp Val Asn Asp Arg Val Leu Glu Leu Leu Ile Met Ile Asn Ala Ser
65 70 75 80

Lys Thr Ala Ser Ala Arg Arg Ile Thr Ala Val Ile Pro Asn Phe Pro
85 90 95

Tyr Ala Arg Gln Asp Arg Lys Asp Lys Ser Arg Ala Pro Ile Thr Ala
100 105 110

Lys Leu Met Ala Asp Met Leu Thr Thr Ala Gly Cys Asp His Val Ile
115 120 125

Thr Met Asp Leu His Ala Ser Gln Ile Gln Gly Phe Phe Asp Val Pro
130 135 140

Val Asp Asn Leu Tyr Ala Glu Pro Ser Val Val Lys Tyr Ile Lys Glu
145 150 155 160

His Ile Pro His Asp Asp Ala Ile Ile Ile Ser Pro Asp Ala Gly Gly
165 170 175

Ala Lys Arg Ala Ser Leu Leu Ser Asp Arg Leu Asn Leu Asn Phe Ala
180 185 190

Leu Ile His Lys Glu Arg Ala Lys Ala Asn Glu Val Ser Arg Met Val
195 200 205

Leu Val Gly Asp Val Thr Asp Lys Val Cys Ile Ile Val Asp Asp Met
210 215 220

Ala Asp Thr Cys Gly Thr Leu Ala Lys Ala Ala Glu Val Leu Leu Glu
225 230 235 240

His Asn Ala Arg Ser Val Ile Ala Ile Val Thr His Gly Ile Leu Ser
245 250 255

Gly Lys Ala Ile Glu Asn Ile Asn Asn Ser Lys Leu Asp Arg Val Val
260 265 270

Cys Thr Asn Thr Val Pro Phe Glu Glu Lys Met Lys Leu Cys Pro Lys

275 280 285

Leu Asp Val Ile Asp Ile Ser Ala Val Leu Ala Glu Ser Ile Arg Arg
290 295 300

Leu His Asn Gly Glu Ser Ile Ser Tyr Leu Phe Lys Asn Asn Pro Leu
305 310 315 320

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<220>
<223> PCR primer

<400> 14

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<210> 15
<211> 26
<212> DNA
<213> Artificial Sequence

<220>
<223> PCR primer

<400> 15

tgtccgccat gtcgtctaca ataata 26

<210> 16
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<400> 16

atatcttgat gaagacgttc accgt 25

<210> 17
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gataatgacg gcttggccgg gaaga 25

<210> 18
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<400> 18

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<223> PCR primer

<400> 19

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<223> PCR primer

<400> 20

tggaccgggc ggtgttcgag ttggg 25

<210> 21
<211> 25
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<213> Artificial Sequence

<220>
<223> PCR primer

<400> 21

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